THESIS

.....

THE DESIGN OF AN ELECTRIC POWER PLANT FOR STOKELY BROTHERS CANNING FACTORY.

.....

Submitted by

W. B. Fairfield

for the degree of
Bachelor of Science
in Electrical Engineering.

.....

Under the direction of

Dr. Charles A. Perkins.

.....

UNIVERSITY OF TENNESSEE

May 30, 1917.

THE DESIGN OF AN ELECTRIC POWER PLANT FOR STOKELY BROTHERS CANNING FACTORY.

Owing to the rapid growth of the business of Stokeley Brothers, it has become necessary to enlarge the plant. The present plant is located on a lot which it entirely covers, so that expansion at the present site is impossible. The power plant is entirely inadequate for the needs of the business. At present it consists of three 100 H. P. return tabular boilers, two of which are ready for the scrap heap, a 75 H. P. Frick Corliss engine, and two 15 H. P. Leffel simple slide valve engines. The machinery, which is driven by these engines, is scattered over a considerable area of floor space, thus necessitating the use of long lineshafts. Since it is necessary that some of the machines be set in such relation to others that the planes of their driving pulleys are at right angles several belts are installed with right angle turns.

The two Leffel engines are placed in an open shed about 200 feet from the boiler plant and steam is conducted to them by an uncovered iron pipe. From this pipe line much loss is incurred.

Taking into consideration all the above mentioned facts, it was deemed advisable to build an entirely new plant upon a near by site, which furnishes ample room for future expansion. The new plant is to be modern in every detail. Many new machines not now used in the factory will be installed. It is, however, beyond the scope of this paper to deal with anything other than the power plant. The writer has nothing to do with the selection of the boilers, since the Engineer in charge has had a wide experience with boilers for use in canning factories. The type of boiler which would be most suitable for power work would probably not be at all adapted to cooking purposes. More than fifty per cent of the capacity of the boiler plant is to be used for cooking.

TYPE OF PLANT TO BE INSTALLED

Since the load is scattered over a considerable area it seems advisable to use a low voltage electric power plant. In a canning factory of this size it would mean a great loss if a break-down of the power plant should occur during the busy season. The three phase transmission line of the Pigeon River Power Company runs along one side of the lots to be occupied by the new plant. Several small 220 volt three phase induction motors are already connected to this line. In order that a source of power may be available in case of a break-down, it is proposed to install a three phase 220 volt generator and use three phase induction motors for driving the various machines.

TYPE AND CAPACITY OF BOILER PLANT.

Two 150 H. P. return tubular boilers are to be installed at present with room in the boiler house for a third of the same capacity.

ENGINE ROOM EQUIPMENT.

From load conditions given by the manager of the plant it is thought desirable to install a 120 K. W. plant, although for the first year the peak load will probably be no more than 100 K. W.

The equipment which has been installed is as follows:

1. Ridgeway simple, single valve engine for direct connection to a 120 K. W. alternator.

2. General electric 240 volt, three phase, 60 cycle alternator with a capacity of 120 K.W. at 80% power factor.

3. 7½ K.W. 1150 RPM, 125 volt, belt driven, compound wound exciter.

4. Black slate combination generator and exciter panel equipped with:

   1. A.C.--500 Ampere Ameter
   2. A.C.--350 volt voltimeter
   3. Field rheostat

4. Field switch
5. Name plate
6. TP-ST-400 ampere switch with fuses.

TABLE SHOWING NUMBER AND HORSE POWER OF MOTORS TO BE INSTALLED.

CORN SECTION

No.Required.	HP of each.	Total HP	¾ load Power Factor	Driven Machine
1	30	30	.90	Corn Huskers
1	10	10	.88	Conveyors
3	7.5	22.5	.88	Silkers, Fillers, Crimpers
1	10	10	.88	Slicers

Total HP for Corn..... 72.5

TOMATO SECTION

No.Required	HP of each	Total HP	¾ Load Power Factor	Driven Machine
2	15	30	.90	Conveyors, etc.
1	7.5	7.5	.88	Fillers
2	10	20	.88	Crimpers, Scalders
1	7.5	7.5	.88	Pulp Machine

Total HP for Tomatoes..... 65.0

PEA SECTION

No.Required	Hp of each	Total HP	¾ Load Power Factor	Driven Machine
1	30	30	.90	Viners
2	10	20	.88	Cleaners, Crimpers
3	7.5	22.5	.88	Grader, Blancher, Fillers
1	3	3	.88	Washer

Total HP for Peas.....75.5

HOMINY SECTION

No. Required	HP of Each	Total HP	¾ Load Power Factor	Driven Machine
1	15	15	.90	Washer, Husker
1	10	10	.88	Crimper, Filler

Total HP for Hominy..... 25

Since corn and tomatoes are the only products which it may be necessary to pack at the same time, it is necessary to purchase only enough motors to operate these two sections. By a careful study of the above tables the following motors were selected as being ample for the operation of the whole plant:

No. Required	HP of Each	Total HP
1	30	30
4	10	40
5	7.5	37.5
2	15	30

Total Motor HP Installed... 137.5

DETERMINATION OF SIZES OF WIRE TO BE USED IN THE DIFFERENT CIRCUITS, ASSUMING A POWER FACTOR OF EIGHTY-FIVE PER CENT

(The letters a, b c, etc., refer to the wiring diagragm on the plant lay-out sheet.)

Cir.	Length Ft.	No of Connected Motors	HP of Connect. Motors	Power Full Load	Factor ¾ Load	K. W .8√3EI	Current I	Total Amperes in Circuit
a	100	1	30	86	81	22.4	74	269
		3	10	.91	.88	22.4	74	
		5	7.5	.90	.88	25.5	84	
		1	15	.91	.88	11.2	37	

b	85	1	10	.91	.88	7.5	25	42
		1	7.5	.90	.88	5.1	17	
c	35	1	30	.86	.81	22.4	74	268
		2	10	.91	.88	7.5	50	
		2	7.5	.90	.88	10.2	34	
		3	15	.91	.88	33.6	110	
d	65	1	30	.86	.81	18.7	61	138
		1	10	.91	.88	7.5	25	
		1	7.5	.90	.88	5.1	17	
		1	15	.91	.88	11.2	35	
e	60	1	30	.86	.81	22.4	74	74
F	100	1	30	.86	.81	22.4	74	194
		2	10	.91	.88	15.	50	
		3	7.5	.90	.88	15.3	50	
g	100	1	30	.86	.81	22.4	74	173
		2	10	.91	.88	15	49	
		3	7.5	.90	.87	15.3	50	
h	50	1	30	.86	.81	22.4	74	74
i	100	1	15	.91	.88	11.2	37	62
		1	10	.91	.88	7.5	25	

SIZE & TYPE OF WIRE, DROP IN EACH CIRCUIT, AND COST OF EACH CIRCUIT.

Cir.	Kind of Insulation	Length ft One Way	Current	Size B & S	Resistance OHMS	Drop in Circuit	Total Drop to End of Line	Cost of Each
a	W Proof	100	270	0000	.015	4.1	4.1	$96.62
b	Rubber	85	42	6	.102	4.3	8.4	17.39
c	W Proof	35	270	0000	.0054	1.5	5.6	33.80
d	Rubber	65	138	00	.0153	2.1	7.7	54.40
e	Rubber	60	74	1	.036	2.7	8.8	33.40
f	W Proof	100	195	000	.015	2.9	7.7	102.50
g	W. Proof	100	175	000	.015	2.6	11.4	102.50
h	Rubber	50	74	1	.030	2.2	13.5	27.80
i	Rubber	100	62	4	.075	4.6	13.2	29.20

METHOD USED IN DETERMINING THE PROPER SIZES OF WIRE

Practically all of the wiring of the plant is indoor work and must be done according to underwriters specifications; so that in no case can the most economical size of wire be used. The proper size of wire for the different circuits was gotten from a table of allowable current carrying capacities of wires in the "National Electrical Code."

The voltage drop at full load current was calculated, and in no case was it excessive, ranging from 1.8% to 6%. A drop of 10% in voltage is permissible if the drop in all of the circuits is approximately the same for the generator voltage may be raised enough to compensate for the drop. All of the circuits which will be used at any one time have approximately the same drop. Full - rated voltage may be supplied to all machines without applying excessive voltage to any one machine.

PLANT EQUIPMENT AND PRICES.

1 Ridgeway Engine fitted to alternator shaft...							$2110.00
1 150 K.V.A., 60 Cycle, 3 Phase, 240 Volt G. E. Alternator.....							1272.15
1 7½ K.W. 125 Volt G. E. Exciter.....							222.75
1 30 H.P. 1200 R.P.M. G. E. Induction Motor....							460.00
4 10 "	1800	"	"	"	" @	212.00	848.00
5 7½ "	1800	"	"	"	" "	182.00	910.00
2 15 "	1800	"	"	"	" "	250.00	500.00
Copper Wire as indicated in Table.....							498.60

Capital Cost & Annual Charges on Motor Installation.....$6821.50

Capacity H.P.	Capital cost per H.P. Installed.	Total H.P. Installed.	ANNUAL CHARGES Interest 5%	Depretiation & Repairs, 6%	Oil care & Operation	Total HP per Annum	Total per Annum
7½	$29.00	37.5	$1.45	$1.74	$3.50	$6.69	$250
10	25.00	40	1.25	1.50	2.75	5.50	220
15	20.00	30	1.00	1.20	2.25	4.45	130
30	19.00	30	.95	1.14	2.00	4.09	123

Total Annual Charges on Motor Installation..... $723

Cost of Engine Room Equipment.....	$6322.90
Cost of Copper Wire.....	498.60
Cost of Building Estimated at.....	1000.00
Cost of Brick Stack 110' High by 3' 7" diameter (Taken from Standard Handbook).....	1492.00
Cost of Boilers Erected (Taken from Standard Handbook)., Increased by 50%, due to present conditions).....	3600.00
Total Cost of Plant.....	$14,713.50

Interest on Investment at 5%.....	736.00
Depreciation & Repairs on Engine Room Equipment and Boilers at 6%.....	485.30
Total Annual Charges on Motor Installation.....	723.00
Cost of Operating Power Plant (Labor supplies, etc.)..	2000.00
Total Fixed Charges per Annum.....	3944.30

COST OF POWER DELIVERED AT MOTORS BASED UPON THE ASSUMPTION OF 12 HOUR POWER DELIVERED 312 DAYS PER YEAR WITH COAL AT $4.50 PER TON

% Full Load	Steam Consumption per K.W Hr. In Pounds	Cost of Coal per K.W. Hr. Cents.	Fixed charges per K.W. Hour Cents.	Total Cost per K.W. Hour Cents.
50	48.33	.957	1.75	2.607
75	45.00	.897	1.17	2.067
100	44.20	.876	.88	1.556
125	45.20	.894	.70	1.594

In the above table the whole boiler plant is charged against the power plant which is unfair, since half the boiler capacity is used in the cooking of the food. This, however, gives us a safe margin for unknown contingencies.

METHODS OF SECURING COST DATA.

Prices of the motors, generators, exciter and switchboard apparatus was given by the General Electric Company through the Knoxville office. Specifications and prices of the engine and alternator were given by the Ridgway Dynamo & Engine Company, of Ridgeway, Pa. The price of the Ridgeway alternator seemed excessive. For this reason a General Electric alternator was selected.

METHOD OF INSTALLING MOTORS.

Since the motors must be moved from place to place at least twice a year, it is highly desirable to have some means of moving them which will be easier than lifting them off their base and loading them on a truck. To facilitate moving these motors they are to be mounted on low-wheeled trucks which have removable axles and wheels. One set of wheels and axles will be sufficient for all the motors; for when the motor is brought to the desired place the truck body may be jacked up and the wheels and axles removed, when the truck frame can be lowered to the floor and bolted down. To one end of the truck frame will be fastened a board to hold the switch and starting compensator. The exact details of construction of the truck are left to the manager of the plant.

METHOD OF UNLOADING COAL.

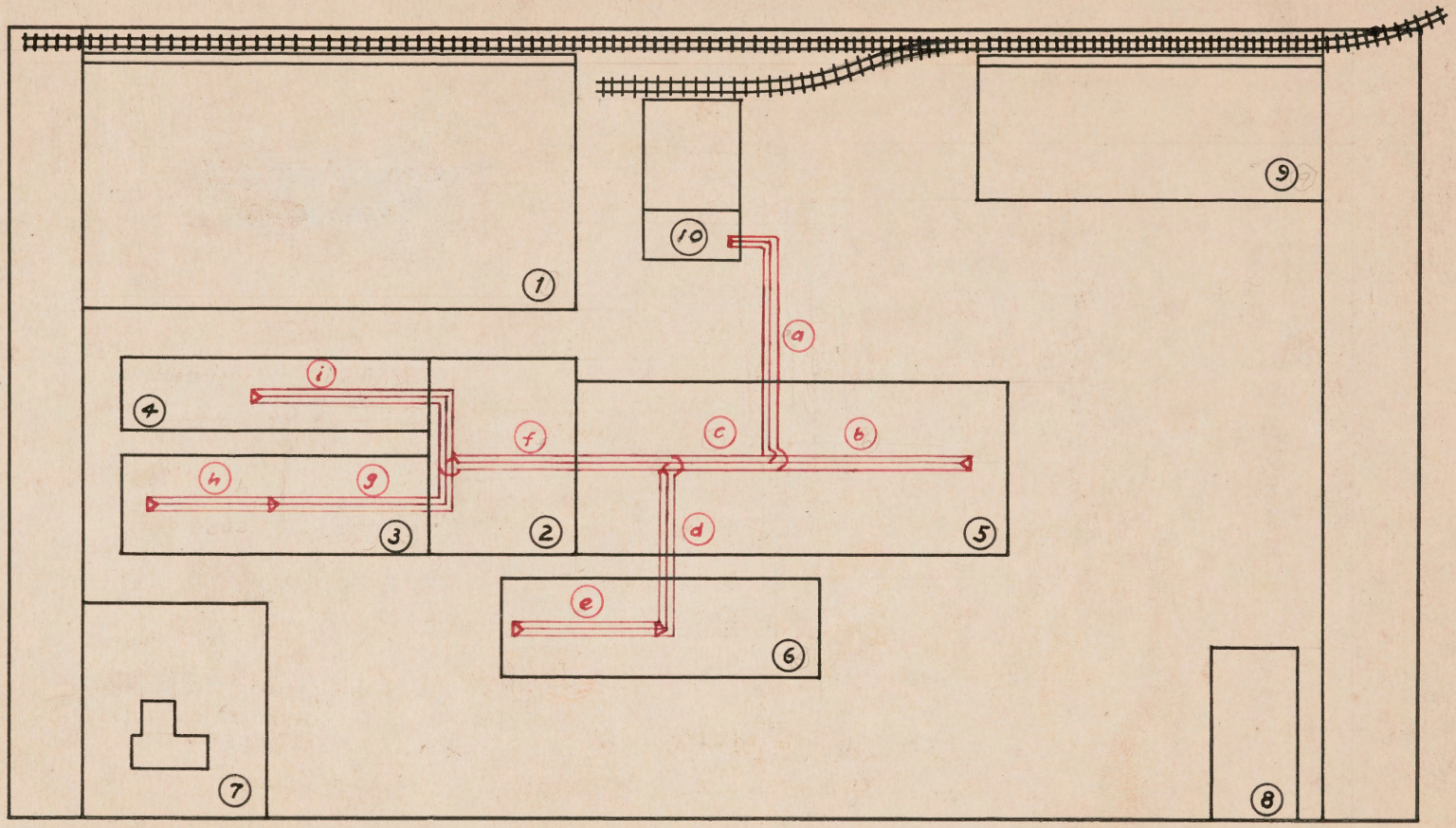
It will be noticed on the plant lay-out sheet that there is a short spur railroad track terminating at the front of the boiler room. This spur is to be constructed with a 5% grade to the end of the boiler room and will be located as close as is possible to the building. The boiler room floor, which will be of concrete, will be two feet below the surface of the ground. This will cause the elevation of the track above the boiler room floor to be approximately six feet. From the side of the railway track farthest from the building an inclined chute is to be built terminating at the floor of the boiler room. By means of this arrangement dumping bottom cars may be unloaded with a very small amount of shoveling.

CORRESPONDENCE.

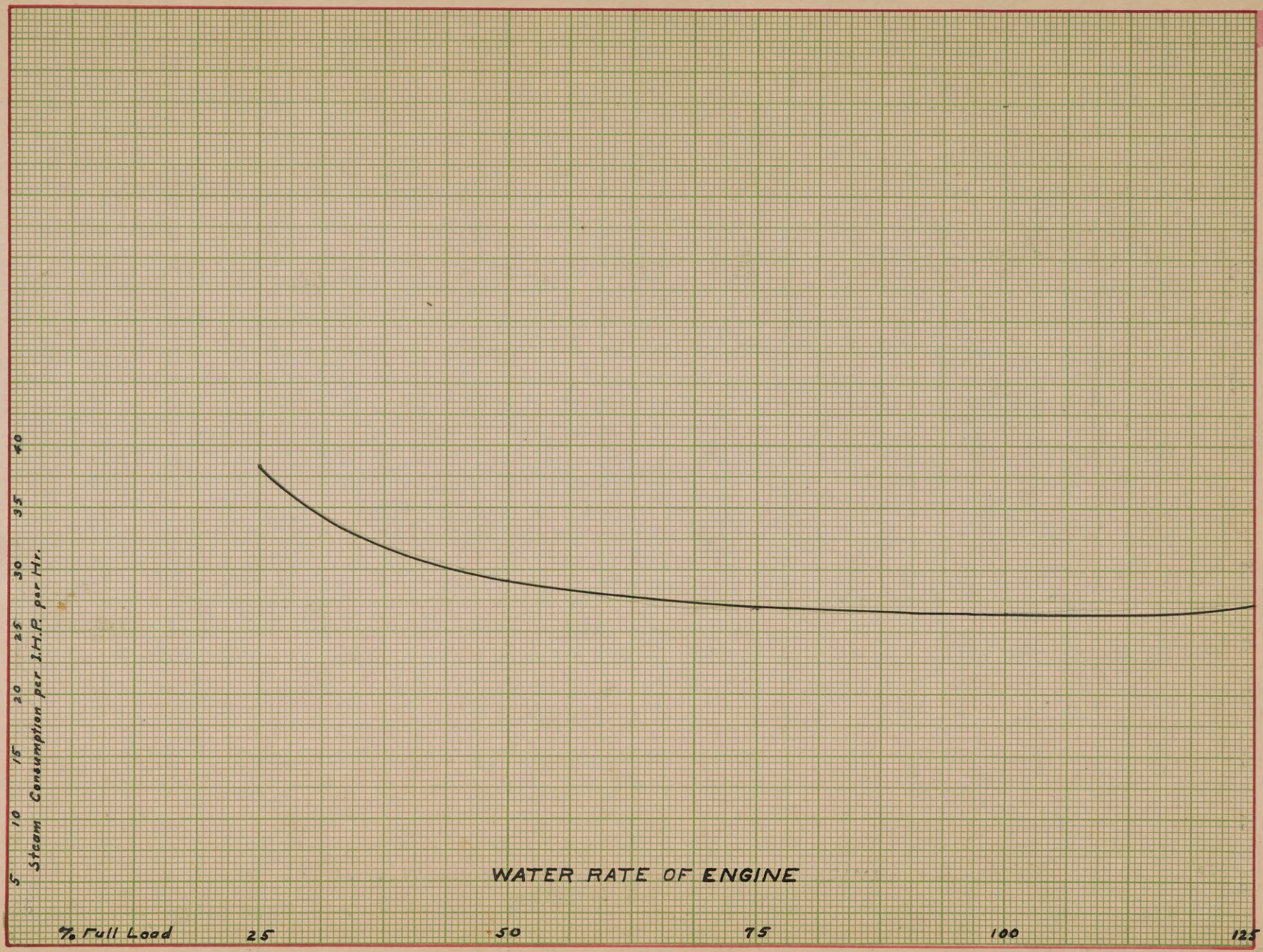
Some of the replies to letters of inquiry are of interest and are included in this paper. The reply of the Ridgeway Dynamo & Engine Company which is in the form of a bid is especially interesting.

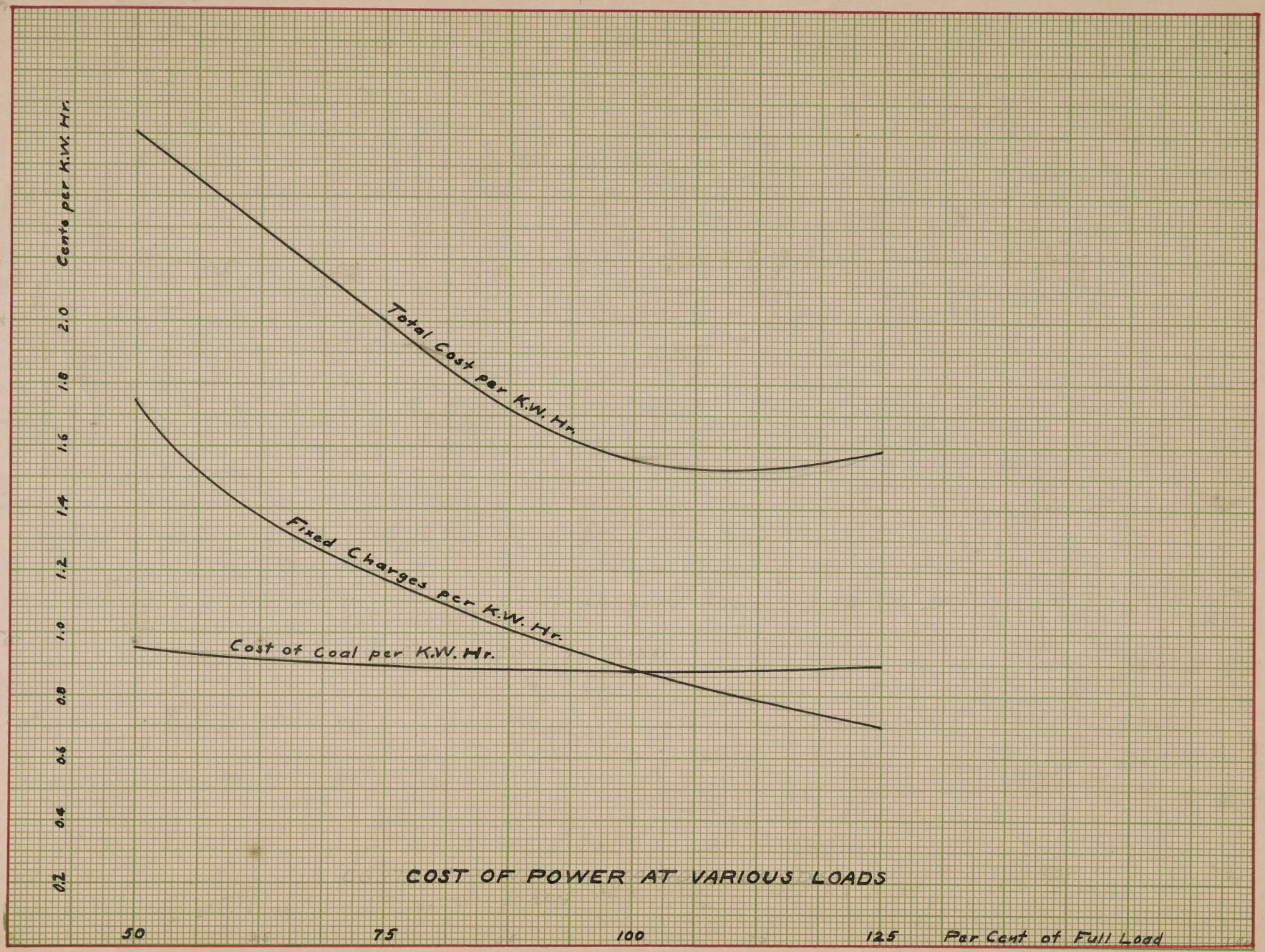
LAYOUT OF STOKELY BROS. CANNING FACTORY

Scale 1½ in = 100 Ft



1	Warehouse	6	Sugar Corn Section
2	Cook Room	7	Book Keepers Residence
3	Pea Section	8	Office
4	Hominy Section	9	Warehouse
5	Tomato Section	10	Power House





COST OF POWER AT VARIOUS LOADS

GENERAL ELECTRIC COMPANY
GENERAL OFFICE
SCHENECTADY, N. Y.

In Reply Refer to

KNOXVILLE OFFICE
805 BANK & TRUST BLDG.

Knoxville, Tenn. April 11th, 1917.

Mr. W. B. Fairfield,
University of Tenn.-Box 1105.
Knoxville, Tennessee.

Dear Sir;-

Replying to your April 10th letter regarding proposed plant for Stokely Bros. Newport, Tennessee, I am pleased to give you the following information.

1 - A.C. Engine Driven Generator - 120 KW-
80% P.F. - 277 RPM - 26 pole - 240 volt-
3 phase - 60 cycle - Revolving Field with
Generator field rheostat and exciter
driving pulley, net, f.o.b. factory.....$1272.15
Shipping weight 6100 lbs.

Efficiency: 100% Power Factor:
Full load 92.2
3/4 " 90.8
1/2 " 88.5

Efficiency at 80% Power Factor:
Full load 88.8
3/4 " 87.4
1/2 " 85.6

1 - 7-1/2 Kw - 1150 RPM - 125 volt - Belt Driven-
Compound Wound-Exciter, with base, pulley and
rheostat.....$222.75
Shipping weight 650 lbs.

Efficiency:
1-1/4 load.....84
Full load.....84
3/4 load.....83
1/2 load.....80

1 - Black Marine Finished Slate Combination Generator
and Exciter Panel, 48" X 20" X 1-1/2", mounted
on 76" pipe supports and equipped with
1 - A.C. - 500 ampere Ammeter
1 - 350 volt - Voltmeter
1 - Concentric Rheostat Mechanism
1 - Field Switch
1 - Name Plate
1 - TP ST - 400 ampere - switch with fuses.
Price.....$132.00

Shipping weight 420 lbs.

GENERAL ELECTRIC COMPANY
GENERAL OFFICE
SCHENECTADY, N. Y.

In Reply Refer to

KNOXVILLE OFFICE
805 BANK & TRUST BLDG.

W.B.F.#2.

As regards the motors, I am pleased to give you sizes, prices and efficiencies below.

Motors are 3 phase - 60 cycle - 220 volt - with bases and pulleys in all cases, and starting compensators on sizes above 5 HP.

		Efficiency				Power Factor.			
		1¼	F.L.	¾	½	1¼	F.L.	¾	½
5 HP-1800 RPM.....	$96.00	79	80	79	76	73	67	57	44.
7½ HP-1800 RPM.....	182.00	85	87	88	86	92	90	87	80.
10 HP-1800 RPM.....	212.00	86	87	88	86	92	91	88	82.
15 HP-1800 RPM.....	250.00	89	90	90	89	92	91	88	80.
15 HP-1200 RPM.....	300.00	88	88.5	88.5	87	90	88	83	72.
20 HP-1200 RPM.....	360.00	88.5	89.5	89.5	88	90	89	85	75.
25 HP-1200 RPM.....	400.00	89	90	90	88.5	81	89	85	75.
25 HP- 900 RPM.....	440.00	88	89	89	88	88	86	81	70.
30 HP-1200 RPM.....	460.00	89	90	90	88.5	91	89.5	85	76.
30 HP -900 RPM.....	520.00	89	90	90	89	88	86	81	70.

On the above motors starting current corresponding to full load, the starting torque is from 3-1/2 to 4-1/2 times full load running current.

Trusting this gives you the desired information and that you will ultimately succeed in having this plant put in, I remain,

Yours very truly,

A. B. Cox

ABC/S. LOCAL MANAGER KNOXVILLE OFFICE.

Ridgway Dynamo & Engine Company

PLEASE MARK REPLY

Attention HBJ

Ridgway, Pennsylvania, April 12, 1917.

Mr. W. B. Fairfield,
University of Tennessee,
Knoxville, Tennessee.

Subject

Attention

Dear Sir:

Your letter of the 24th.ult. has been neglected and we wish to apologize to you for not having given your very courteous inquiry more prompt attention. We have, however, been very busy in our Office the last few months and occasionally a matter which is nor particularly pressing has been of necessity neglected in this manner. We sincerely trust that the delay will not be of serious inconvenience to you and that the information we are sending you will arrive in time to be of some value.

We note that the exhaust steam is to be used in heating water and presume that consequently the engine will operate on a slight back pressure. Under these conditions the proper type of engine is a plain single slide valve engine, as steam economy is not a matter of prime importance and the additional cost of a Uniflow or four-valve engine is not justified.

We note that you mention 125 KW. as the capacity of the plant and since your load will probably be mostly small induction motors, the powerfactor will probably be low. Consequently we have figured on a 150 KVA. generator, which at 80% P.F. will give you 120 KW. This is the nearest standard generator that meets your requirements.

We are enclosing specifications and formal proposal covering this engine as we believe you will find our forms and manner of making such a proposal of interest. We also enclose a dimension sheet on which you will find indicated these dimensions applying to the unit which we are specifying.

As a point of further interest we would say that our price is composed of $2060.00 for the engine, $1920.00 for the alternator and $304.00 for the exciter. We would say that were we selling the engine separately we would charge about $50.00 additional to cover the cost of fitting our shaft and making a special subbase to fit some other manufacturer's generator.

We have assumed a working steam pressure of 140# to the square inch as we thought likely you would figure on 150# as the limit of your boiler capacity, under which conditions the working pressure is usually about 10# less. Also we have assumed a back pressure as ranging from zero to 2#. In this connection we would

Mr. W. B. Fairfield,
Knoxville, Tennessee

advise that the cylinder size we have selected actually figures out something like 210 HP at 257 revolutions with atmospheric exhast. We have assumed 480-Volts for the alternator voltage, although this could be changed to 220, 550 or 2400 without changing the price of the set. Our proposition doesn't include the exciter belt.

You can calculate the amount of concrete required in the engine foundation from the dimension sheet, which we enclose. This will approximate 24-cu.yds.

Our specifications give the steam consumption in pounds per I.H.P. hour and the efficiency of the alternator at various loads. The mechanical efficiency of the engine will be approximately 94%. This gives you data sufficient to enable you to calculate the steam consumption in pounds per kilowatt hour should you wish to do so.

The car load freight rate on this equipment from Ridgway to Knoxville is 51 cts. per hundred pounds, the minimum carload weight being 30,000#.

We trust that you will find our suggestions of interest and assure you that we will be glad to give you further information should you desire it.

Thanking you for your interest in our products, we are

Yours very truly,
RIDGWAY DYNAMO & ENGINE COMPANY

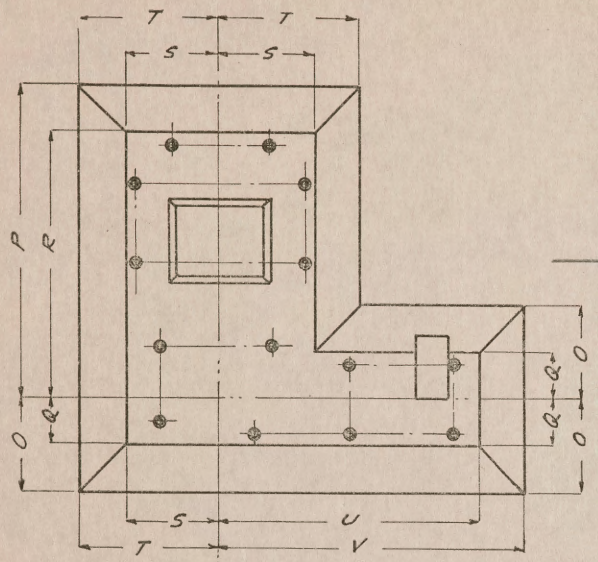
Henry B. Jones

Sales Department.

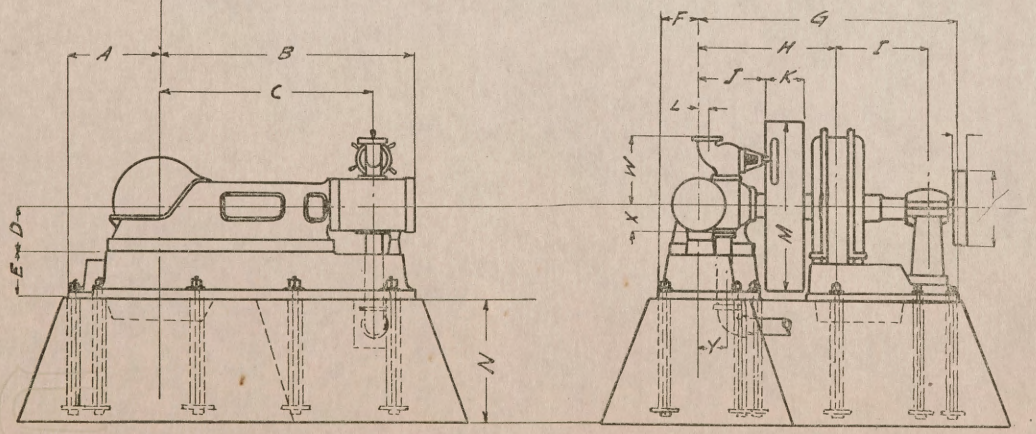
HBJ/EL
Enclosure.
Bulletins.

16

48-P



Bed	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
B	26½	73	68¾	14	13	12	78¾	42½	30⅜	18½	12	2¼	50	36	28	99⅛	15	86½	30	43	53	66	18¾	7½	5¾
D	26⅛	84¼	70⅜	16	17	13	86	45½	30½	20⅜	13	2½	58	42	31	104	16	89	30	45	65	80	21	9¼	6⅜
D	29	84¼	70⅜	16	17	13	91¼	47	33	20⅜	13	2⅜	58	42	31	109	16	94	32	47	65	80	21	9¼	6¾
F	33¼	97	81½	18½	17⅓	15	98¼	52¼	34¼	24	15	3	66	48	36	119	18	101	36	54	100	118	23¼	9¾	7
F	40½	97	81½	18½	17⅓	15	103	54	37¼	24	15	3	66	48	36	124	18	106	44	62	100	118	23¼	9¾	7
H	33¼	109	92	20⅛	18	17	103½	58	34¾	28½	16	2¼	74	54	40	126	20	106	37	57	114	134	25	11¾	7¾
H	40½	109	92	20⅛	18	17	108¼	59½	37¼	28½	16	2¼	74	54	40	132	20	112	44	64	114	134	25	11¾	7¾
H	50	109	92	20⅛	18	17	115½	59½	38	28½	16	2¼	74	54	40	139	20	119	50	70	114	134	25	11¾	7¾
I	50	121	104	20½	18	17	115¼	59½	38	28½	16	2¼	76	54	40	139	20	119	50	70	124	144	25	11¾	7¾
J	46⅜	123	103½	22½	23⅓	19⅓	121	65	40	31½	18	3⅜	82	60	45	147	23	125	51	73	127	149	29½	12	11
K	46⅜	135	113¼	22½	23⅓	19½	121	65	40	31¼	18	3⅜	84	60	45	147	23	125	51	73	137	159	29½	12	11
L	52	136	115	24½	21⅓	20⅛	127⅓	72⅛	41¼	35	20	3⅓	90	66	48	155	24	131	56	80	142	166	30	13¾	9¾
M	52	156	132	24½	21⅓	20⅛	127¼	72½	41¼	35	20	3⅓	92	66	48	155	24	131	56	80	159	183	30	13¾	9¾
N	66	163¾	138	29	17	22	141⅓	81½	44⅛	42¼	22	7⅓	108	102	63	181	26	144	66	103	168	205	36¾	17	14
O	66	183⅓	155	29	17	22	141⅓	81½	44⅛	42¼	22	7⅓	110	102	63	181	26	144	66	103	188	225	36¾	17	14



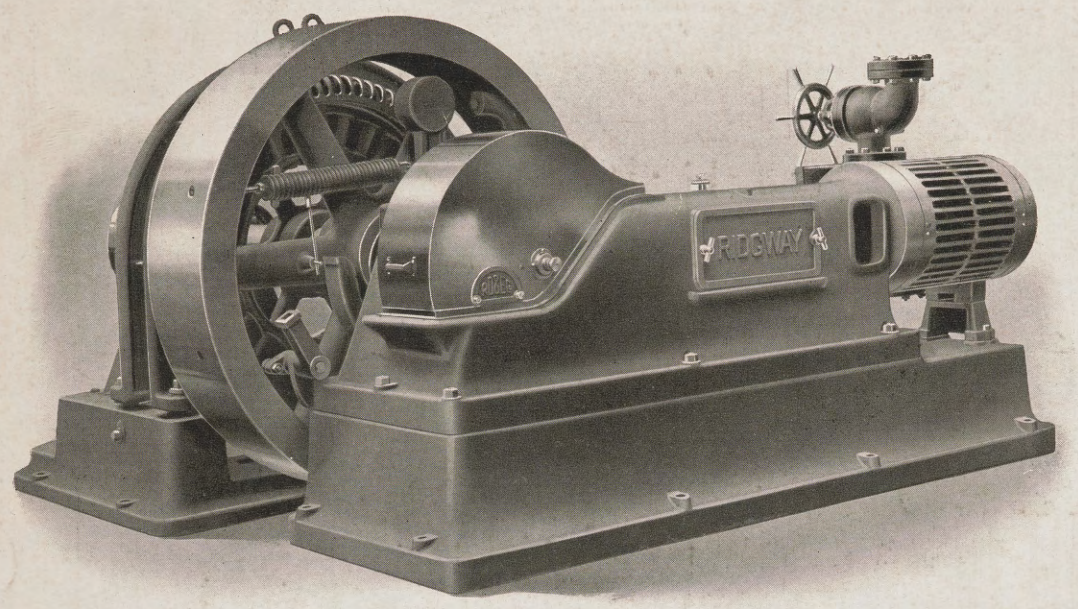
APPROXIMATE DIMENSIONS OF
SIMPLE SINGLE VALVE ENGINES
D.C. TO ALTERNATING CURRENT
GENERATORS

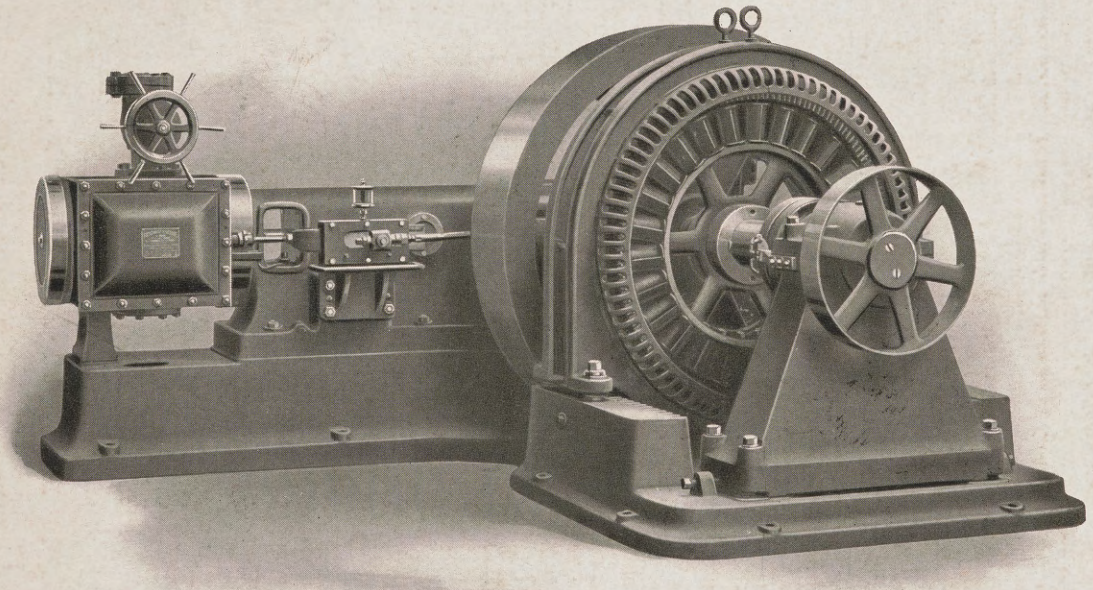
RIDGWAY DYNAMO & ENGINE CO.
RIDGWAY, PA.

MAY 13, '14

The Ridgway Dynamo & Engine Co.

Ridgway, Pa.





Side Crank Engine, Right Hand. Engine Type Alternator.

(On sizes over 150 K. W. the generator is supported on separate sole plates.)

The Ridgway Dynamo and Engine Co.

ENGINE SPECIFICATION

No. 41217

For W. B. Fairfield,

Knoxville, Tennessee

TYPE

This engine will be a RIDGWAY. Simple, Enclosed, Side Crank. Single. Valve Engine for direct connection to a 150 K.V.A. Ridgway Alternator.

CAPACITY

The engine will be capable of developing 200 indicated horse-power when cutting off at 1/4 stroke with an initial steam pressure of 140 pounds at the throttle, ---- inches vacuum, 0-2 pounds back pressure.

DIMENSIONS

Diameter of cylinder	14 inches.
Length of stroke	16 inches.
Speed	257 rev. per min.
Diameter of governor wheel	72 inches.
Face of governor wheel	16 inches.
Diameter of belt wheel	---- inches.
Face of belt wheel	---- inches.
Diameter of steam pipe	5 inches.
Diameter of exhaust pipe	6 inches.
Length of engine over all	12 feet 1 inches.
Width of engine over all	10 feet 2 inches.
Shipping weight of engine	22,800 pounds.

FITTINGS

Throttle valve. Nickel plated Sight-feed cylinder lubricator. Exhaust flange. Globe valves, pipe and fittings for cylinder and steam chest drains. Grease cups for valve gear. Special adjusting wrenches. One gallon engine oil. One gallon cylinder oil. Eye bolts for handling main bearing caps. Foundation bolts, templet and washers.

Single Four-Valve Engine.

DIMENSIONS OF PARTS

Main bearing, - - - - diam. 8 in., length 16 in.

Crank pin, - - - - - " 6 in., " 4 in.

Cross head pin, - - - - " 3-1/2 in., " 4 in.

Outboard bearing, - - - " 6-1/2 in., " 13 in.

Piston Rod, H. P., - - - " 2-1/2 in.

" " L. P., - - - " ------ in.

Crosshead shoe, - - - - area, 104 sq. in.

Connecting rod, - - - - length 42 in.

Largest section, - - - 7 sq. in.

Smallest section, - - - 4-3/4 sq. in.

Governor wheel, weight, - - 4400 lbs.

Belt wheel, weight, - - - ------ lbs.

ECONOMY

Under the conditions of load, steam pressure, and speed as given below, the consumption of dry steam will not exceed the following weights. These results to be arrived at by comparing the weight of condensed exhaust steam with the average indicated horsepower of the engine, all the conditions to be maintained as nearly constant as possible and test to continue for at least one hour. The fulfillment of the guarantees is to be determined by comparing the average of the amounts given with the average of the results of tests at the same load points.

Speed 257 r. p. m. Initial steam pressure 140 pounds.

Vacuum 0 inches. Back pressure 0 pounds.

Load 25% Steam 37.3 lbs. per I. H. P. per hour.

" 50% " 27.8 " " "

" 75% " 25.6 " " "

" 100% " 25.3 " " "

" 125% " 26.0 " " "

Add 2.3% at each point for each pound of back pressure.

Side Crank Engine

BED

The Bed will be of very heavy design, having a box section with bored guides. The guides and end to receive the cylinder will be bored and turned at one setting on a special tool, insuring perfect alignment. An opening of ample size will be cored in one side of the bed to give easy access to the cross head and connecting rod. This opening will have suitable guards for catching and retaining all oil and will be provided with a light removable cover. A removable false head or partition will be located between the cross head and cylinder, provided with packing around the piston rod.

Openings in each side of the bed will give ample room for packing piston rod stuffing box, the drips from which will be caught and removed by a separating well at the crank end of the bed, without being mixed with the oil in the crank case.

A light, substantial, sheet steel, oil tight guard will enclose the crank. This guard will be hinged at the top and will be arranged to be turned back over the bed to give easy access to the crank pin and connecting rod. A small opening in the side of the guard, having a swinging cover, will provide means of inspecting the crank pin while the engine is in motion.

MAIN BEARING

The Main Bearing will be of the wedge-adjusting, two-part type the shells being lined with genuine babbitt pened and bored. These shells will be so built that they can be removed for inspection and repair by lifting the shaft a small amount.

LUBRICATING SYSTEM

The engine will be built for oiling by the "splash system," in which the crank disc throws a steady stream of oil over the crosshead and guides, and from pockets on the inside of the oil hood, the oil is led through large channels to the crank pin and main bearing. From all bearings the oil flows back to the reservoir under the disc to be used over.

SHAFT

The Main Shaft will be of open hearth steel, forged out of a solid ingot. The balance disc will be of semi-steel with crank pin cast solid therewith. The disc will be carefully fitted to the shaft and in addition to a heavy force fit, will be securely keyed in place.

SUBBASE

The engine bed will be mounted on an extra heavy cast iron sub-base.

A separate subbase will be provided for supporting the alternator and outboard bearing.

OUTBOARD BEARING

The Outboard Bearing will be of an extra heavy design lined with genuine babbitt, pened and bored. It will be self-aligning and self-oiling and will be adjustable in vertical and horizontal directions.

CYLINDER

The Cylinder will be made of hard, close grained, cast iron and will be of ample thickness to allow reboring. The head on the crank end will be cast solid with the cylinder. The loose head will be fitted with a metal to metal joint requiring no packing. The barrel of the cylinder will be neatly lagged and the enclosed space filled with insulating material.

The piston will be a single casting , thoroughly ribbed and of ample strength, although cored out and made as light as possible. The packing rings will be of cast iron of the self-adjusting type, carefully fitted to prevent leakage of steam. The piston rod will be of the best machinery steel fitted to the piston with a long taper and jamb nut.

Four-Valve Engine

VALVES AND VALVE GEAR

The steam valves will be of the double ported semi-balanced, Corliss type, giving ample port opening with small travel at all points of cut off. They will work in removable cages of hard, close-grained cast iron, and will be ground or lapped to a perfect fit, insuring steam tightness. The exhaust valves will be of the Corliss type, double ported and semi-balanced. The steam valves will be driven by the governor eccentric through an accelerating gear located in a cast iron case on the side of the bed and immersed in oil. Motion from this gear will be transmitted direct to the arms on the valve stems. The accelerating gear consists of a simple combination of arms and links having adjustable bearings. This gear gives rapid motion to the valves at the time of opening and closing, but allows them to remain stationary during the unbalanced period. The exhaust valves will be operated by a wrist plate motion from a fixed eccentric on the main shaft and will also have very slight movement during the time when the pressure thereon is heavy.

All valve gear bearings will be lined with adjustable and removable bronze bushings, and those outside of the gear case will be lubricated by compression grease cups.

On Cross Compound Engines the valve gear for each cylinder will be operated as above, except that the low pressure accelerating gear will be driven by the fixed eccentric on the shaft.

On Tandem Compound Engines the accelerating gears will be mounted on the cylinders. The high pressure gear will be driven by the eccentric on the governor, while the low pressure gear and the single wrist plate, which controls all exhaust valves, will be driven by a fixed eccentric on the shaft.

GOVERNOR

The Governor will be of our well known inertia type mounted within the fly wheel. The inertia bar will be carried on a large roller bearing fitted with hardened steel bearing pin and bushings. The eccentric and strap will be split so that they may be removed without disturbing the shaft or governor. The strap will be lined with genuine babbitt pened and bored and provided with means for ample lubrication. This governor is powerful and extremely sensitive, but sudden and extreme movements of the inertia bar will be dampened by dash pots.

CONNECTING ROD

The Connecting Rod will be single forging of open hearth steel of the solid end type. The wrist pin boxes will be of phosphor bronze of the split box type and the crank pin boxes will be of the same type lined with genuine babbitt. The adjustment at both ends of the rod will be by wedge blocks securely held by two bolts.

CROSS HEAD

The Cross Head body will be of cast steel of ample size and strength. The lower shoe will be of phosphor bronze and both shoes will be provided with wedge adjustment. The piston rod will be connected to the cross head by a long thread and jamb nut, securely locked in place. The cross head pin will be fitted in the cross head body with a long taper at each end and will be made with hardened and ground surface. This pin will be arranged so that it may be turned 90° as it wears.

GUARANTEES

We guarantee all material and workmanship to be first-class in every respect and agree to furnish without charge on cars at our works, any or all parts which may prove to be defective within one year from date of shipment of machinery.

We guarantee that this engine when tested in our Works will be carefully adjusted, and the change in speed between no load and full load will not exceed..1-1/2.....per cent.

Form D10-B, 5-16, 1M.

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The Ridgway Dynamo and Engine Co.

Specification for an

ALTERNATING CURRENT GENERATOR.

For... W. B. Fairfield,.....

...Knoxville, Tennessee.....

TYPE ..Engine.....Type .....257.....R. P. M. ...3.....Phase

....60.....Cycles .....480.....Volts .....28.....Poles

CAPACITY Rated capacity, continuous (120 KW at 80% P.F). 150.....K. V. A.

Current per line full load - - - .....181.....amperes.

Overload capacity .....25.....per cent. .....2.....hours.

Momentary overload - - - - .....75.....per cent.

Shipping weight - - - - - .....6800.....pounds.

GUARANTEES Regulation at 100% power factor - - .....9.....per cent.

Regulation at 80 % power factor - - .....20.....per cent.

Temperature rise, 100% power factor 80% P. F.

Full load.....35°.....deg. C. 40°C

Above overload.....50°.....deg. C. 55°C

Efficiency, 100% power factor

125% load 92.0.....per cent.

100% load 92.9.....per cent.

75% load 91.4.....per cent.

50% load 89.0.....per cent.

INSULATION Between stator winding and iron....1500....volts for.....1.....min.

Between rotor winding and iron...1500.....volts for.....1.....min.

EXCITER ..Belted....Type ....10..... K. W. ...1200.....R. P. M.

Shipping weight...1200.....pounds.

The exciter will be of ample capacity to excite the generator at the above loads with temperature rises not exceeding those specified for the generator. With the exciter will be furnished sliding base, pulley, and field rheostats for exciter and generator.

Alternating Current Generator.

STATIONARY ARMATURE

The armature core will be built of punchings of thin transformer steel, especially selected for this work on account of its low hysterisis and superior magnetic qualities, which are not obtainable in ordinary stock. These punchings will be securely held in place and supported by a substantial cast iron frame, and will be insulated from each other by varnish and paper to reduce eddy currents.

The frame will consist of two heavy castings of I beam section to give stiffness and the core will be clamped accurately in position by bolts which pass through the core, but outside of the magnetic circuit. As the external face of the core is entirely open and ample air ducts are provided, the most perfect ventilation results. Neat and substantial guards bolted to the frame will protect both ends of the winding from mechanical injury.

The windings will be of formed coils, impregnated with insulating varnish and baked into a solid mass, or of bars, carefully insulated with tape and varnish and baked before being put in place. The slots in the core will be lined with heavy insulating material before the winding is started, and the dielectric strength of the insulation will be ample for all requirements and will not deteriorate when subjected to higher temperatures than those covered by the guarantees. All coils will be interchangeable and held in place by retaining wedges.

REVOLVING FIELD

The field spider will be of cast steel of substantial design and proportioned to resist the heaviest strains that may be imposed upon it. The rim will be carefully turned to receive the pole pieces, which will be built up of laminated steel punchings, securely held in place by heavy bolts passing through the rim of the spider, or dovetailed and keyed in the smaller sizes.

The field coils will consist of either rectangular copper conductors or copper strip on edge, wound on forms and thoroughly insulated with varnish and other materials of the best quality. These coils will be firmly held in position by the projecting pole tips so that they can not be displaced by vibration or centrifugal force while the machine is in operation.

COLLECTOR RINGS

The current for exciting the field coils will be conducted thereto through carbon brushes bearing on cast iron collector rings mounted on the shaft and carefully insulated therefrom.

BELTED AND COUPLED TYPE

The armature will be mounted on a substantial cast iron base provided with slide rails and a ratchet shifting device. The bearing pedestals will be separate and will be bolted and doweled to the base. The shaft will be of open hearth steel with journals of large diameter running in self-aligning and self-oiling bearings lined with babbitt. A pulley of suitable dimensions or a flanged coupling for connection to the prime mover will be furnished.

TESTS

All tests are to be made in accordance with the recommendations of the American Institute of Electrical Engineers.

Form C1, 5-16, 3M.

The Ridgway Dynamo and Engine Co.

Ridgway, Pennsylvania April 12,1917.

W. B. Fairfield,

Knoxville, Tennessee,

Dear Sir:-

For and in consideration of the hereinafter named amounts, we propose to furnish you machinery and materials enumerated below, in accordance with the foregoing specifications:

One (1) 14 x 16 "Ridgway" Single-Valve Engine -

And

One (1) 150 KVA. "Ridgway" Alternator with-

One (1) 10 KW. "Ridgway" Belted Exciter,

PRICE:- FORTY-THREE HUNDRED($4300.00) DOLLARS.

GUARANTEES

THE RIDGWAY DYNAMO & ENGINE CO., hereinafter referred to as the "Company" guarantees that the electrical and mechanical construction of all of the machinery and materials furnished under this contract, will be first class in every respect and will replace or repair without charge f. o. b. Ridgway, Pa., or point of manufacture, any or all parts which may prove to be defective in workmanship or material within one year (60 days for motors) from date of shipment. Economy and efficiency tests will be made only at the Works of the Company and will be subject to an extra charge.

ERECTION

If desired by the Purchaser, the Company will furnish the services of an engineer to superintend the erection and starting of the machinery and material specified herein, for the sum of $8.00 per day, plus all necessary traveling and hotel expenses. The Purchaser agrees to furnish all common labor, blocking, tackle, etc., required in connection with these services. The Company will not be responsible for the correct performance of this apparatus unless installed and started under the supervision of one of its engineers.

In case it is elsewhere agreed herein that the Company shall erect the machinery and material herein specified, then the Purchaser agrees to furnish easy access to the location where the machinery and material is to be erected, and will also furnish all necessary supports, foundations and grouting unless otherwise specified herein. In the event of delays in erecting and starting, for which the Company is not responsible, the Purchaser agrees to compensate the Company for the time lost by its superintending engineer, including the expenses of the second and any additional trips at the rate specified in the preceding paragraph.

TERMS

All payments are to date from date of invoice, in accordance with the following terms. No discount for cash will be allowed unless it be so stated herein. In case of partial shipments made at different times, prorata payments shall be made therefor. If shipment or erection of the machinery and material herein specified or any part thereof, shall when ready, be delayed by the Purchaser, it is understood and agreed that payments shall become due, the same as though shipment had been made or erection completed.

Fifty (50) percent. Sight Draft attached to Bill of Lading.
Twenty-five (25) percent. thirty days from date of Bill of Lading.
Twenty-five (25) percent. sixty days from date of Bill of Lading.

The title and ownership of the property, furnished under the terms of this contract, shall remain in the Company until full and final payment therefor shall have been made by the purchaser according to the terms above named and agreed upon and until notes, if any, shall have matured and been settled in full. In case of default of any of the payments above provided for, the Company may repossess itself of the property furnished under this contract, wherever found, and shall not be liable in any action in law, on the part of said purchaser, for such reclamation of its property, nor for the repayment of any money or moneys, which may have been paid by said purchaser in part payment for said installation and equipment.

DELIVERY

The machinery herein specified will be delivered by us F. O. B. cars,

Ridgway, Pennsylvania,

SHIPMENT

The machinery herein specified will be shipped Approximately 8 to 10 Months.

after acceptance of this contract and receipt of all other information necessary to proceed with construction. It is further understood and agreed that the Company shall under no circumstances or in any event, be held responsible or liable for any loss, damage, detention, or delay caused by fire, strike, civil or military authority, or circumstances beyond their control, or by insurrection or riot, and the purchaser, in accepting this contract, agrees to assume, and, does hereby assume, all responsibility, from the time the machinery and the material covered by this contract shall have been delivered to the transportation companies, and during the installation of the said machinery and until the same has been accepted and paid for.

The foregoing is the agreement between said parties as it exists at this date, and it is agreed and distinctly understood that all previous communications between said parties, either verbal or written, contrary to the provisions hereof, are hereby withdrawn and annulled; and that no modification of this agreement shall be binding upon the parties hereto, or either of them, unless such modification shall be in writing, duly accepted by the purchaser, and approved by the President or Directors of the Company.

The foregoing proposal is subject to the approval of the President or Directors of the Company, and may be modified or withdrawn, unless accepted within fifteen days from date thereof.

Respectfully submitted,

RIDGWAY DYNAMO & ENGINE CO.

Per Henry B. Jones

The foregoing proposal is hereby accepted this ..... day of ..... 191...

.....

(Purchaser sign here)

Approved this ..... day of ..... 191...

RIDGWAY DYNAMO & ENGINE CO.,

By .....President